

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2004/003142

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29C67/00 B29C67/02 B29C67/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01/38061 A (KHOSHNEVIS BEHROKH ; UNIV SOUTHERN CALIFORNIA (US)) 31 May 2001 (2001-05-31)	1,2, 11-13, 15, 19-21, 23-28, 30,33-37
Y	claims 1,7-19	29
Y	US 6 500 378 B1 (SMITH JEFFREY M) 31 December 2002 (2002-12-31) column 9, line 7 - column 10, line 17 ----- -/--	29

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

9 December 2004

Date of mailing of the international search report

17/12/2004

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB2004/003142

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 147 138 A (HOECHSMANN RAINER ET AL) 14 November 2000 (2000-11-14)	1,2, 11-13, 15,16, 19-21, 30,31, 33-37
Y	column 2, lines 20-42; claims; figures	17,18,32
Y	EP 0 535 984 A (SPECTRA GROUP LTD INC) 7 April 1993 (1993-04-07) column 6, lines 21-57	17,18,32
X	US 5 985 204 A (OZAKI MOTOAKI ET AL) 16 November 1999 (1999-11-16) column 4, line 31 - column 5, line 25; figures 4-7,10,15 column 6, lines 25-49 column 7, lines 17-52 example 3	1,2,11, 14, 19-21, 23,28, 33,36,37
X	DE 44 16 901 A (EOS ELECTRO OPTICAL SYST) 16 November 1995 (1995-11-16)	1,2,5,11
Y	column 4; claims; figures	3,4,7,8, 12
A		6
X	US 4 752 498 A (FUDIM EFREM V) 21 June 1988 (1988-06-21)	21, 23-25, 32,35-37
Y	column 6, lines 10-12; figures	3,4,7,8, 12
	column 6, lines 26-32; claims 7,8 column 3, lines 54-63; claims 15,18,19 column 3, line 38 - column 4, line 6	
A		5,6,9, 10, 13-20, 26-31, 33,34
X	US 2003/052105 A1 (NAGANO KAZUHIKO ET AL) 20 March 2003 (2003-03-20) page 3, paragraph 23 - paragraph 25 page 11, paragraph 131 - paragraph 141 page 15, paragraph 178 - page 16, paragraph 195	1,2, 9-12, 19-25, 28,29, 33,34, 36,37
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2004/003142

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/149137 A1 (JANG BOR ZENG ET AL) 17 October 2002 (2002-10-17) the whole document	1,2, 9-12, 19-25, 33,36,37
A	US 5 182 056 A (SPENCE STUART T ET AL) 26 January 1993 (1993-01-26) column 49, line 22 - column 50, line 23; claims 1-7,23-29	17,18,32

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter Application No

PCT/GB2004/003142

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0138061	A	31-05-2001	AU 4301501 A WO 0138061 A1 US 6589471 B1	04-06-2001 31-05-2001 08-07-2003
US 6500378	B1	31-12-2002	NONE	
US 6147138	A	14-11-2000	DE 19723892 C1 AT 234192 T DE 59807431 D1 EP 0882568 A2 ES 2192289 T3	03-09-1998 15-03-2003 17-04-2003 09-12-1998 01-10-2003
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INTERNATIONAL SEARCH REPORT

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International Application No

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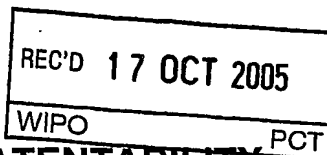
PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)




Applicant's or agent's file reference RR/DAL/8475INT	FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/GB2004/003142	International filing date (day/month/year) 20.07.2004	Priority date (day/month/year) 25.07.2003	
International Patent Classification (IPC) or national classification and IPC B29C67/00, B29C67/02, B29C67/04			
Applicant LOUGHBOROUGH UNIVERSITY ENTERPRISES LIMITED et al.			

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 8 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
 - a. ☒ sent to the applicant and to the International Bureau) a total of 4 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in Item 4 of Box No. I and the Supplemental Box.
 - b. ☐ (sent to the International Bureau only) a total of (Indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand 16.03.2005	Date of completion of this report 18.10.2005
Name and mailing address of the International preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Mathey, X Telephone No. +31 70 340-2686



INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/003142

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

Description, Pages

1-19 as originally filed

Claims, Numbers

1-19 received on 19.05.2005 with letter of 19.05.2005

Drawings, Sheets

1/8-8/8 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/GB2004/003142

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-14,16,17
	No: Claims	15,18,19
Inventive step (IS)	Yes: Claims	1-14,16,17
	No: Claims	15,18,19
Industrial applicability (IA)	Yes: Claims	1-19
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re. Item V

1.1 Reference is made to the following documents:

D1: WO-A-0138061 (KOSHNEVIS) 31 May 2001 (2001-05-31)

D2: US-A-6147138 (HÖCHSMANN ET AL.) 14 November 2000 (2000-11-14)

1.2 The following is stated under reference to item VIII, whereby it is to be noted that unclear features cannot be used for unambiguously distinguishing over prior art in order to assess novelty or inventive step.

2. INDEPENDENT CLAIMS

2.1 Document D1 is regarded here as being the closest prior art to the subject-matter of claim 1, and this document discloses a method of selectively sintering particulate material comprising the steps of

- (i) providing a layer of particulate material,
- (ii) providing radiation over the layer of particulate material,
- (iii) varying the absorption of the provided radiation across a selected surface portion of the layer to sinter a portion of the material of the layer,
- (iv) providing a further layer of particulate material overlying a prior layer of particulate material including a previously sintered portion of material,
- (v) repeating steps (ii) and (iii) to sinter a further portion of the material within the overlying further layer and to sinter said further portion with the previously sintered portion of material in the prior layer
- (vi) successively repeating steps (iv) and (v) to form a three-dimensional object, where step (iii) comprises varying the radiation absorption at the particulate material over the selected surface portion of the layer by providing varying amounts of *another material over portions of the layer outside of the selected surface portion of the layer*, cf. D1, claims 1, 2 and 28, page 6, line 17- page 7, line 5, and page 10, line 11 - page 11, line 2.

The subject-matter of claim 1 differs therefrom in that said other material is radiation absorbent.

Consequently, the subject-matter of claim 1 is novel in the sense of Article 33(2) PCT.

The objective problem solved by this technical feature can be construed as making a controlled use of the energy dispensed, by making the heat absorbed by the material to be sintered a controllable factor.

D2 discloses the use of a moderating agent to melt, or cause a chemical reaction of, a binder material coating on the particulate material, see col.3 lines 48-54 and claim 12. The hint that is given there to the skilled person is rather to influence the physical, chemical or biological properties of the powder.

Even though adjusting the energy absorptivity of a powder batch by adding a moderating material has been disclosed in the prior art, the disclosed prior art documents do not suggest an *ad hoc* addition of *varying amounts of* radiation absorbent material to *locally and selectively* modify the energy absorptivity of the powder. Consequently, the subject-matter of claim 1 is inventive in the sense of Article 33(3) PCT.

2.2 Claim 14 differs from claim 1 only by minor changes in the wording and seems to describe a method that does not significantly differ from the method of claim 1. Since this method is not anticipated by the prior art, the method of claim 14 also fulfills the novelty requirements of Article 33(2), as well as the inventive activity requirements of Article 33(3) PCT.

2.3 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 15 is not new in the sense of Article 33(2) PCT:

D1 discloses an apparatus for sintering particulate material comprising a controller for enabling the exposure of a surface portion of a layer of particulate material to radiation, where the controller is arranged to control the variation of absorption across said surface portion by controlling the deposition of variable amounts of sintering inhibitor material over the layer of particulate material, cf. D1, page 8, lines 8-15. Under reference to item VIII 3, it is the opinion of the examining division that such an apparatus would also be suitable for depositing variable amounts of *radiation absorbent material* instead of *sintering inhibitor material*. Indeed, this feature relates to the use of the apparatus and cannot distinguish over D1's apparatus features, i.e.

the apparatus of D1 does not differ from the apparatus of claim 15, see PCT Guidelines 5.23.

Consequently, claim 15 does not either meet the requirements of Article 33(3) PCT regarding inventing activity.

3. DEPENDENT CLAIMS

3.1 Since it has been found that claim 1 fulfills the criteria of Article 33(2) and (3) PCT, the dependent claims 2-13 also fulfill these criteria.

3.2 The subject-matter of claim 16 differs from the apparatus disclosed in D2 in that the controller of the apparatus is responsive to temperature variation across the surface portion of a layer of particulate material. Therefore claim 16 fulfills the requirements of Article 33(2) regarding novelty.

The concept of making the controller of a dispenser of additive material responsive to temperature variations is not disclosed in the retrieved prior art, nor are there any elements to suggest it. Consequently, Claim 16 also fulfills the requirements of Article 33(3) PCT. Being dependent from claim 16, claim 17 therefore also meets the requirements of Article 33(2) and (3) PCT.

3.3 In view of the lack of clarity of claims 18 and 19, it cannot be confirmed, at this stage of the procedure, that they fulfill the requirements of Article 33(2) and Article 33(3) PCT.

4. Claims 1-19 fulfill the requirements of Article 33(4) PCT.

Re. item VII

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 and D2 is not mentioned in the description, nor are these documents identified therein.

2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
3. The independent claims are not in the two part-form in accordance to Rule 6.3(b) PCT, with those features known in combination from the prior art being placed in the preamble (Rule 6.3(b)(i) PCT) and the remaining features being included in the characterizing part (Rule 6.3(b)(ii) PCT), see also item V, point 2.1.

Re. item VIII

The application does not meet the requirements of Article 6 PCT, because claims 15, 18, 19 are not clear.

1. Claim 15 relates to an apparatus for sintering particulate material, but contains mainly results to be achieved, namely *enabling the exposure of a surface portion of a layer* and *controlling the variation of radiation absorption across said surface portion*, rather than a technical definition of the means employed to achieve these results, cf. PCT Guidelines 5.37.
2. Claims 18 and 19 do not comply with Rule 6.2(a) since they rely on the description in a vague way and do not contain clear technical features, cf. PCT Guidelines 5.10.
3. It is to be noted that the expressions "for sintering" or "for enabling", in claim 15, must be understood as "suitable for sintering", respectively "suitable for enabling" see PCT Guidelines 5.23 and 5.25.
4. The application contains 5 independent claims: claims 1, 14 and 18 relating to a method and claims 15 and 19 relating to an apparatus. Although they have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter in each category and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

International application No.

PCT/GB2004/003142

Claims

1. A method of selectively sintering particulate material, comprising the steps of:

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- (i) providing a layer of particulate material;
- (ii) providing radiation over the layer of particulate material;
- (iii) varying the absorption of the provided radiation across a selected surface portion of the layer to sinter a portion of the material of the layer;
- (iv) providing a further layer of particulate material overlying a prior layer of particulate material including a previously sintered portion of material;
- (v) repeating steps (ii) and (iii) to sinter a further portion of the material within the overlying further layer and to sinter said further portion with the previously sintered portion of material in the prior layer;
- (vi) successively repeating steps (iv) and (v) to form a three-dimensional object;

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characterised in that step (iii) comprises varying the radiation absorption at the particulate material over the selected surface portion of the layer by providing varying amounts of radiation absorbent material over the selected surface portion of the layer.

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2. A method according to claim 1, wherein step (iii) comprises providing a first level of radiation absorption on a first area of the selected portion and a second different level of radiation absorption on a second area of the selected portion, contiguous with the first area.

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3. A method according to claim 2, wherein step (iii) comprises providing a third different level of radiation absorption on a third area of the selected portion, contiguous with the second area.

4. A method according to claim 2 or claim 3, wherein step (i) comprises providing a first particulate material in the first area and a second different particulate material in the second area of the layer.

5 5. A method according to claim 1, wherein step (ii) comprises providing radiation on a combination area in which particulate material is to be sintered, the combination area including a centre portion and an edge portion, and step (iii) comprises providing greater radiation absorption at the edge portion than at the centre portion.

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6. A method according to claim 5, wherein the absorption of the radiation increases from a minimum value at the centre portion to a maximum value at the edge portion.

15 7. A method according to claim 5 or claim 6, wherein step (ii) comprises providing radiation on a non-combination area contiguous with, and external to, the combination area, and step (iii) comprises varying the absorption of the provided radiation so that the absorption of the radiation over the non-combination area is less than the absorption of the radiation over the edge
 20 portion of the combination area.

8. A method according to claim 7, wherein the absorption of the radiation over the non-combination area is less than the absorption of the radiation over the centre portion of the combination area.

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9. A method according to any of the preceding claims, wherein step (iii) comprises logically dividing the surface area of the selected portion into an array of segments, and providing a different level of radiation absorption on different segments in the array.

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10. A method according to claim 9, wherein step (iii) comprises creating a bitmap image that divides the surface area into a plurality of segments.

11. A method according to any of the preceding claims, wherein step (iii) comprises providing radiation absorbent material for absorbing a first wavelength of radiation over a first area of the selected surface portion, and providing radiation absorbent material for absorbing a second different wavelength of radiation over a second area of the selected surface portion.
12. A method according to claim 11, wherein the method comprises providing radiation having a first wavelength over the layer of particulate material to combine the material in the first area, and providing radiation having a second wavelength over the layer of particulate material to combine the material in the second area.
13. A method according to any of the preceding claims, wherein step (iii) comprises providing varying amounts of radiation absorbent material over the selected surface portion of the layer by printing radiation absorbent material onto the selected surface portion.
14. A method of selectively sintering particulate material, comprising the steps of:
- (i) providing a layer of particulate material;
 - (ii) varying the absorption of provided radiation across a selected surface portion of the layer to sinter a portion of the material of the layer;
 - (iii) providing a further layer of particulate material overlying the prior layer of particulate material including the previously sintered portion of material;
 - (iv) varying the absorption of provided radiation across a selected surface portion of the further layer to sinter a further portion of the material within the overlying further layer and to sinter said further portion with the previously sintered portion of material in the prior layer;
 - (v) successively repeating steps (iii) and (iv) to form a three-dimensional object;

characterised in that the variation of radiation absorption in steps (ii) and (iv) is obtained by providing varying amounts of radiation absorbent material over the selected surface portion of the layer and the further layer
5 respectively.

15. Apparatus for sintering particulate material, the apparatus comprising a controller for enabling the exposure of a surface portion of a layer of particulate material to radiation, characterised in that the controller is arranged
10 to control the variation of radiation absorption across said surface portion by controlling the deposition of varying amounts of radiation absorbent material over the layer of particulate material.

16. Apparatus according to claim 15, wherein the controller is responsive
15 to temperature variation across the surface portion and is arranged to control the deposition of varying amounts of radiation absorbent material in response to the temperature variation.

17. Apparatus according to claim 16, wherein the controller is arranged to
20 control the deposition of different radiation absorbent materials capable of absorbing different wavelengths of radiation directly onto the surface portion of the layer, and to enable the exposure of the surface portion to radiation of different wavelengths.

25 18. A method of selectively sintering particulate material substantially as hereinbefore described with reference to the accompanying drawings.

19. Apparatus for sintering particulate material substantially as
30 hereinbefore described with reference to the accompanying drawings.